

Evaluation By:
UNITED VIDEO, INC.
of the
MA/COM SCRAMBLING SYSTEM

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1. SUMMARY

1. The 50% error rate was never better than 1×10^{-2} under any conditions - this may be suitable for digital audio, but would have to improve by an order of magnitude to be useful for "real" data transmission.

2. The error rate is somewhat better than 1×10^{-2} (1 x 10⁻²). This is by the way the error rate to the National Bureau of Standards and would have to be improved before it could be used for data transmission.

3. The video signal is not as good as the audio signal. This is a problem that has to be solved for video transmission.

SUMMARY

10/10/10

I. SUMMARY

1. The bit error rate was never better than 1×10^{-5} under any conditions - this may be suitable for digital audio, but would have to improve by an order or magnitude to be useful for "real" data transmission.
2. The digital channels died in the presence of subcarriers (1×10^{-2}). Both the digital data and audio channels were unuseable. This is by far the most serious drawback to the Ma-Com system and would have to be resolved before it would be useable for WGN use.
3. The VideoCipher caused no significant degradations by itself. Its' operation was affected by our subcarriers. This is a problem that will have to be resolved for proper VideoCipher operation.

DISCUSSION

II. DISCUSSION

The following data was gathered during the two day testing period of June 25th and 26th, 1985. Testing at the uplink was performed in conjunction with Randy Pike from Ma/Com. Test results are based on satellite transmission. The 10 meter antenna and S.A. receiver were used.

VIDEO

The VideoCipher II system introduced no significant video degradations. The VideoCipher was tested using WGN video and NTSC test signal video. The VideoCipher did not add extra bandwidth components in either case.

Authorization times for the descramblers ranged from one to five seconds when applying video to the descrambler. Authorization times for the system scrambler/descrambler combination ranged from five to fifteen seconds.

The descrambler units will output video supplied to it via a bypass input when the unit is not authorized or non-scrambled video is being received. The bypass video is routed to the descrambler output by a relay. No additional degradation occur to the bypass video.

SUBCARRIERS

The VideoCipher II caused no degradations to the WGN subcarriers. BER tests were conducted over the Zephyr mux. Four million bits with 0 errors were sent over a mux channel. This is equivalent to a BER of better than 2.5×10^{-7} . 3.2 million bits were transmitted over EPGJR with 0 errors. This equivalates to a BER of better than 3.1×10^{-7} . There were no visable degradations on the Zephyr facsimile services or other audio services.

VIDEOCIPHER II DIGITAL CHANNELS

A BER test was conducted over the 9.6 kp/s data channel. This data channel is transmitted along with two other digital audio channels and digital authorization code information. The performance of all the digital channels is reflected by the performance of the 9.6 kb/s data channel. The BER without subcarriers was 1.0×10^{-5} . Randy Pike said a BER of 1.0×10^{-5} was typical. This is an unacceptable BER for data transmission.

There was no noticeable audio degradations on the digital audio channels.

The performance of the digital channel with subcarriers was significantly worse. The BER fell to 6.12×10^{-3} . High frequency clicks were present on the digital audio channels. The authorization channel was also affected, but its' performance could not be accurately determined. The descramblers were able to receive authorization, but times ranged between three to five seconds.

HOME SAT TEST

The home satellite testing utilized a 5 meter Paraclipse antenna and a MAS Pro SRA-500 receiver with a SR-3 Homesat RF module. Video quality was acceptable using this setup. Subcarriers could not be checked using this receiver due to a -42 dBm baseband output level. BER through the digital channel was 7.2×10^{-3} without subcarriers, and 2.2×10^{-2} with subcarriers. There was obvious interference on the digital audio channels when subcarriers were present.

The MAS PRO SR2-D receiver would not authorize the VideoCipher. No further testing could be conducted.

The Ma/Com H1 receiver was tested also, using the 5 meter Paraclipse. The VideoCipher was able to receive authorization. The BER without subcarriers was 3×10^{-2} . Severe audio interference was present. With subcarriers, synchronization could not be achieved over the digital channel. The digital audio channel was completely interrupted. Home Sat testing used a 10 dB C/N ratio.

VIDEOCIPHER II OBSERVATIONS

Ma/Com did not have the capability to perform individual descrambler authorization/de-authorization. Their system was set-up using a fixed set of codes.

The scrambler would take occasional hits where it would glitch to the unscrambled mode. It would take approximately ten seconds for the system to resync. The digital audio and data channels were also interrupted during this time. Randy Pike could not explain the cause of this problem; however, by reseating the cards in the encoding unit seem to help.

It was also found that the Di-Tech video distribution amplifiers will have to be modified to operate properly with scrambled video. Di-Tech video distribution amplifiers are used exclusively throughout the uplink video system.

TEST PLAN
(with notes)

I. LOOPBACK

A. Procedure - Pre Test (See configuration 1)

1. Perform differential gain (5%), phase (3°), chroma-luma intermod (2%), luminance nonlinearity, chroma delay (0), and frequency response (-0.3, -0.4, -0.6, -0.9, -0.7, -1.58 dB) with no subcarriers. Note any discrepancies and resolve if possible.
2. Add subcarriers, and 2 dB pad between Tek 149 and 4.2 LPF. Determine that no significant degradations occur. Note all changes from Step 1. (No further degradations)
3. Verify that all subcarriers are received -1 dB from that transmitted. Subcarriers should be in accordance with the attached baseband plan (5/22/85).

B. Bypass Mode Operations (See configuration 2)

1. With Ma/Com encoder and decoder in bypass mode, note any added system degradations that are present. Record results. (No degradations noted, relay bypass).
2. Reduce video amplitude to .8v pp and verify that the system functions properly. (Scrambler would not accept .8v pp video. Had to attenuate the output of scrambler for .8v pp output).
3. Add subcarriers to the subcarrier coupler and verify that bypass mode is still operational - wait five minutes. (ok)
4. Verify that no additional distortions are present, particularly subcarrier to luminance crossmodulation, by performing the tests in I, A-1.

Difference gain - 1%

Difference phase = 3.5°

Intermod - 2°

Croma-luma delay - 0

Frequency Response - $+0.2, 0, -0.2$,

- .2, - .2, -2.6 dB

C. Encoder - Decoder Operation

1. Connect the test equipment (figure 3) directly to the output of the encoder while in bypass mode and record the spectrum for two minutes no max hold. Store in Channel B. (No bypass output - used subcarrier coupler output instead).
2. Place encoder in "scramble" mode and record spectrum on max hold as in Step 1. Record any added bandwidth components. (Graphed upon straight video).
3. Restore test configuration as in figure 2. Power decoder off for one minute. Restore power to decoder. With subcarriers OFF,

verify proper operation of decoder. Note authorization time (video .8v pp). (2 seconds used - 1v pp input video, .8v pp output video).

4. Repeat Step 3 with subcarriers ON. Note any change in authorization time. (none)
- *5. Remove subcarriers. Put encoder in scramble mode. When decoder authorizes, note any degradations to the video caused by the scrambling process using the tests from I, A-1.
- *6. Add subcarriers and repeat Step 5.
- *7. Record BER of digital audio channel with and without subcarriers.
- *8. Record BER of test channel on Z-mux during scrambling, and normal operation. Record results (this step may be done concurrently with Step 7).

***Testing was not performed**

II. SATELLITE TESTING

NOTE: Transponder time has been reserved on June 25th and 26th, 8 a.m. to 5 p.m. CST. Before accessing TR21 G-1, notify Donna Rotunno at HBO (212-477-7531), then proceed with the normal crosspolarization checks by calling Hughes before beam up.

A. Pre Test Procedure

1. Perform differential gain, phase, chroma-luma intermod, luminance nonlinearity, chroma delay, and frequency response with no subcarriers. Note any discrepancies and resolve if possible.

Difference gain - 3.7%

Difference phase - 3°

Intermod - 4.2°

Chroma-luma delay - 0

Frequency Response - 0, -.2, -.4, -.7, -.7, -3 dB

2. Add subcarriers, and 2 dB pad between Tek 149 and 4.2 LPF. Determine that no significant degradations occur. Note all changes from Step 1.
3. Verify that all subcarriers are received ± 1 dB from that transmitted. Subcarriers should be in accordance with the attached baseband plan (5/22/85), see page 11.
4. Reduce TX power until occasional impulse noise is visible in the video. Record C/N by measuring I.F. power with receiver in manual gain, then beam down.
5. Restore normal uplink configuration.

B. Bypass Testing (See configuration 2)

- *1. With Ma/Com encoder and decoder in bypass mode, note any added system degradation that are present. Record results.
- *2. Reduce video amplitude to .8v pp and verify that the system functions properly.
- *3. Add subcarriers to the subcarrier coupler and verify that bypass mode is still operational - wait five minutes.
- *4. Verify that no additional distortions are present, particularly subcarrier to luminance crossmodulation, by performing the tests in I, A-1.

***No encoder bypass**

C. Encoder-Decoder Operation

1. Restore test configuration as in figure 2. Power decoder off for one minute. Restore power to decoder. With subcarriers OFF, verify proper operation of decoder. Note authorization time (video .8v pp). (2 seconds used - 1v pp input video, .8v pp output video).
2. Repeat Step 1 with subcarriers ON. Note any change in authoization time. (none)
3. Remove subcarriers. Put encoder in scramble mode. When decoder authorizes, note any degradations to the video caused by the scrambling process using the tests from I, A-1.

Difference gain - 2.7%
Difference phase - 3°
Intermod - 3%
Chroma-luma delay - 0
Frequency response - 0, -.4, -.4, -.7,
-.5, -2.8 dB.

4. Add subcarriers and repeat Step 3.

Difference gain - 1%
Difference phase - 3.5°
Intermod - 3%
Chroma-luma delay - 0
Frequency Response - +.2, 0, -.2, -.2,
-.2, -2.6 dB

5. Record BER of digital audio channel with (6.12×10^{-3}) and without (1×10^{-5}) subcarriers.
6. Record BER of test channel on Z-mux during scrambling (2.5×10^{-7} , 0 errors), and normal operation (2.5×10^{-7} , 0 errors). Record results (this step may be done concurrently with Step 5).

D. Near Threshold Performance (**Did not perform**)

1. Remove HPA output from uplink antenna.
2. Record noise floor (Receiver in manual gain).
3. Bring HPA power up slowly until a C/N equalsto that of II, A-4 is achieved.
4. Restore test configuration as in figure 2. Power decoder off for one minute. Restore power to decoder. With subcarriers OFF, verify proper operation of decoder. Note authorization time (video .8v pp).
5. Repeat Step 4 with subcarriers ON. Note any change in authoization time.

6. Remove subcarriers. Put encoder in scramble mode. When decoder authorizes, not any degradations to the video caused by the scrambling process using the tests from I, A-1.
7. Add subcarriers and repeat Step 6.
8. Record BER of digital audio channel with and without subcarriers.
9. Record BER of test channel on Z-mux during scrambling, and normal operation. Record results (this step may be done concurrently with Step 8).

III. HOME SAT

Note: Since at this time it is not known which receivers will be available to us, as well as if these receivers will function at a 10 dB C/N with subcarriers, this portion of the test plan may be changed on site to maximize the amount of information obtainable.

A. Downlink Testing

1. Reduce uplink power until downlink C/N is approximately 10 dB.
2. Install various receivers as available to test the following:
 - a - Proper authorization and decoding
 - b - Video quality (impulse free?)
 - c - Subcarrier audio quality
 - d - Digital audio chan quality
 - e - BER digital channel

	Rx1	Rx2	Rx3
	1 second	none	15 seconds
	none	none	none
	*could not check	** N/A	very poor
subs	interference	** N/A	very poor
no subs	marginal	** N/A	very marginal
subs	2.2×10^{-2}	** N/A	would not sync up
no subs	7.2×10^{-3}	** N/A	3×10^{-2}

Rx1 = Maspro SRA-500 Receiver

Rx2 = Maspro SR2-D Receiver

Rx3 = Ma/Com H1 Receiver

* = Baseband output level was -42 dbm, too low to check subcarrier quality

** = Could not achieve authorization. Could not complete tests.

3. Test each receiver at 13 dB C/N for items 2a thru 2e. Record results.

UNITED VIDEO BASEBAND PLAN

TRAFFIC	FREQ	DEV(MHZ)	M.I.	BBP(DBM)	FIRST SB	REL LVL	
WGN	6.8000	1.4144	.2080	-18.73264	-19.65933	0	1
NMC	4.8375	.3981263	.0823	-29.67838	-27.71261	-10.94573	2
GOES 1	4.8825	.4018298	.0823	-29.60036	-27.71261	-10.86772	3
GOES 2	4.9275	.4055332	.0823	-29.52301	-27.71261	-10.79036	4
SPARE	4.9725	.4092367	.0823	-29.44633	-27.71261	-10.71369	5
DATA CABLE	5.0175	.4129402	.0823	-29.3703	-27.71261	-10.63765	6
EPG JR	5.0850	.526906	.1036	-27.25826	-25.7134	-8.525612	7
ZEPHYR MUX	5.1750	.53613	.1036	-27.10997	-25.7134	-8.377323	8
NAFAX	5.2425	.4314578	.0823	-28.99955	-27.71261	-10.26691	9
DIFAX	5.2875	.4351613	.0823	-28.92721	-27.71261	-10.19457	10
MBI L	5.4000	.7722001	.1430	-23.95017	-22.91388	-5.21753	11
SMN1 L	5.5800	.79794	.1430	-23.6721	-22.91388	-4.939453	12
SMN1 R	5.7600	.8236801	.1430	-23.40244	-22.91388	-4.6698	13
SMN2 L	5.9400	.8494201	.1430	-23.14074	-22.91388	-4.408098	14
SMN2 R	6.1200	.8751601	.1430	-22.88654	-22.91388	-4.1539	15
WFMT L	6.3000	.7182	.1140	-24.60806	-24.8825	-5.87542	16
WFMT R	6.4800	.73872	.1140	-24.36767	-24.8825	-5.635027	17
EPG	7.2377	.940901	.1300	-22.28113	-23.74173	-3.548489	18
SMN3 L	7.3800	1.05534	.1430	-21.28644	-22.91388	-2.553797	19
SMN3 R	7.5600	1.08108	.1430	-21.07984	-22.91388	-2.347191	20
SEEBURG	7.6950	.7972021	.1036	-23.72752	-25.7134	-4.994879	21
UPI MUX	7.7850	.806526	.1036	-23.62774	-25.7134	-4.8951	22
MBI R	7.9200	1.13256	.1430	-20.68063	-22.91388	-1.947989	23
SPORT TRAK	8.0550	.8344981	.1036	-23.33501	-25.7134	-4.60237	24
SEEBURG 2	8.1450	.8438222	.1036	-23.23956	-25.7134	-4.50692	25

DEVIATION OF MAIN CARRIER BY SUBCARRIERS AND DISP. (.5 MHZ) ONLY: 3.952053

VIDEO DEVIATION= 8.600001 MHZ

OCCUPIED BANDWIDTH= 35.21922 MHZ

VIDEO DEVIATION	OCCUPIED BANDWIDTH
5.601097	30
6.203007	31
6.788393	32
7.361202	33
7.924158	34
8.479227	35
9.027861	36

01-01-1980

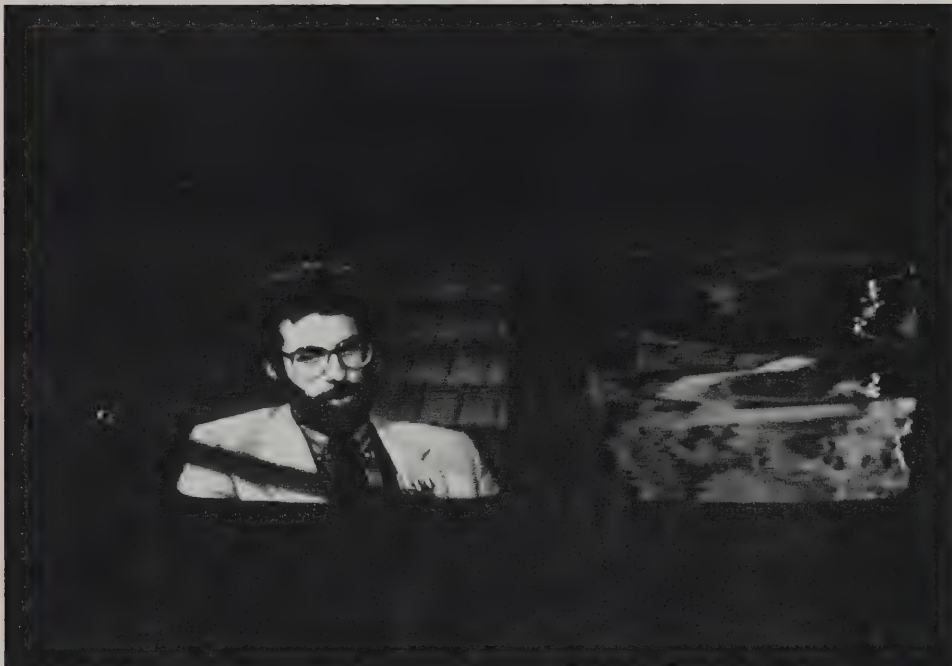
OFFICIAL BASEBAND PLAN AS OF 7-04-85

GRAPHS

PICTURES



UPLINK VIDEO TEST SIGNALS



OFF AIR WGN / SCRAMBLED WGN SATELLITE DOWNLINK



SCRAMBLED VIDEO



UNSCRAMBLED VIDEO TEST SIGNALS



DOWNLINK RF SPECTRUM

A = Unscrambled.....B = Scrambled



DOWNLINK RD UNSCRAMLED

Left = WGN TransponderRight = Transponder 5

